MASTER OF SCIENCE
IN
APPLIED PHYSICS

DISCRETE-MODE SOURCE DEVELOPMENT AND TESTING FOR NEW SEISMO-ACOUSTIC SONAR

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A seismo-acoustic sonar concept that uses guided interface waves (Rayleigh or Scholte) is being developed to detect buried ordnance in the sea floor and beach sediments. This thesis describes the initial research conducted into the design, construction, and field testing of possible seismic sources that excite preferentially the interface waves desired for use in such a system. The theory of elasticity shows that seismic interface waves have elliptical particle velocity orbits in the vertical plane along the path of propagation. It was therefore decided that to selectively excite the desired interface waves, a harmonic source employed at the interface must induce elliptical particle motion in this plane. Several exploratory sources were developed to produce this type of excitation. Field tests of the discrete-mode sources developed were conducted to evaluate this hypothesis, but due to the non-optimum nature of the experimental sources, perfect discrete source excitation was not obtained. However, it was found that the medium itself acted as a selective filter for the interface waves after a few tens of meters of propagation. The experimental results obtained here suggest that the basic concept of discrete-mode excitation looks promising.

DoD KEY TECHNOLOGY AREA: Other (Mine Warfare, Mine Countermeasures)

KEYWORDS: Seismo-Acoustic Sonar, Seismic Surface Waves, Rayleigh Waves, Scholte Waves, Buried Ordnance Detection, Mine Detection

INVESTIGATION OF THE EFFECTS OF VARIOUS NOZZLE CONFIGURATIONS ON SOLID-ROCKET-PLUME INTENSITIES AND SPECTRA

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Subscale rocket motors were fired and the plume signatures were measured in the infrared (IR) and ultraviolet (UV) wavelength regimes. Band-averaged and spectral data were recorded using an SR5000 IR spectrometer (2.5 to 5.5 μm range), an Agema 870 IR thermal imaging camera (3.5 to 5 μm range), and the Naval Postgraduate School UltraViolet Imaging Spectrometer (NUVIS) (325 to 405 nm range). Rocket motor nozzle geometries were varied to determine the effects of over- and under-expansion on the plume band-averaged intensity and spectra. Four different solid rocket propellants were used: X-61, NWC-278, AC-13, and AC-14. The enhanced mixing nozzle, used in conjunction with the X-61 propellant, reduced the plume signature in both the UV and IR regions. The total UV intensity of the plume decreased by about 30%

and varied as function of distance from the rocket nozzle. The intensity difference was more pronounced at shorter wavelengths (325-385 nm) than at longer wavelengths (385-405 nm). The difference in power was not as large in the IR region (about 7%). Intensity results from the analysis of the NWC-278, AC-13, and AC-14 runs were inconclusive. Data from the NUVIS and Agema instruments were used to create spectra for each of the propellants. While distinct features were discernible in the UV spectra, they could not be identified with a specific atom or molecule. The IR spectra were characterized by several molecular bands attributed to a combination of CO_2, H_2O, and HCl.

DoD KEY TECHNOLOGY AREAS: Aerospace Propulsion and Power, Sensors

KEYWORDS: Solid Propellant Rocket, Rocket Plume Spectra, Rocket Plume Intensity, Plume Signature